(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 860 587 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
26.08.1998 Bulletin 1998/35

(51) Int. Cl.[6]: **F01D 5/08**

(21) Application number: **98102563.8**

(22) Date of filing: **13.02.1998**

(84) Designated Contracting States:
AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **21.02.1997 JP 37647/97**

(71) Applicant:
Mitsubishi Heavy Industries, Ltd.
Tokyo (JP)

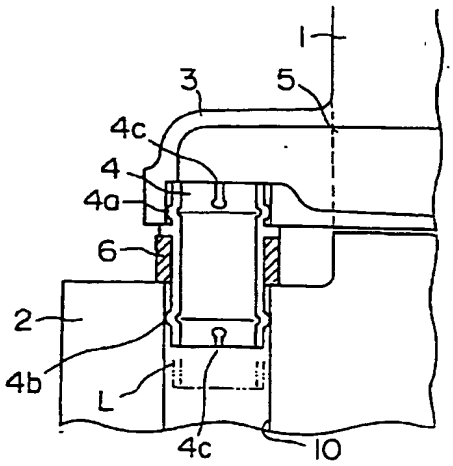
(72) Inventor:
Matsuo, Asaharu,
Mitsubishi Heavy Industries Ltd.
Takasago-shi, Hyogo-ken, 676-8686 (JP)

(74) Representative:
Henkel, Feiler, Hänzel
Möhlstrasse 37
81675 München (DE)

(54) Connector for the transfer of a cooling fluid from a rotor disc to a turbomachine blade

(57) An improved cooling medium path structure for cooling a gas turbine blade comprising a disk-side cooling medium path, a blade-side cooling medium path formed at the root portion of the blade and a delivery block disposed between the two cooling medium paths so as to establish communication between them. The delivery block is provided with an elastic engaging section which comes into elastic and line- contact with the disk-side cooling medium path and the blade-side cooling medium path whereby the sealing property of the contact portions of the structure is secured to allow a cooling medium to be supplied without leaking from the cooling medium paths and the heat of the cooling medium generated as a result of cooling the high-temperature portion of the gas turbine can be taken out so as to make the best use of it for other purposes.

Fig. 2



EP 0 860 587 A2

NSDOCID: <EP___0860587A2_I_>

Description

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a cooling medium path structure of a root portion of a gas turbine blade.

Prior Art

The structure of a conventional cooling medium path of the above type will be described with reference to Figs. 11 through 13. In the outer periphery of a turbine disk 2 there are formed in the axial direction a plurality of inverted Christmas tree-shaped blade grooves 7 at equal intervals in the circumferential direction so as to correspond in number to turbine blades 1 fitted in the respective stages.

At the same time, in a root portion of the turbine blade 1, there are provided inverted Christmas tree-shaped portions 8 which can be assembled into the above-mentioned inverted Christmas tree-shaped grooves 7 with a very small gap therebetween.

The turbine blade 1 is inserted to be assembled into the respective groove of the turbine disk 2 one by one in the axial direction so that during the operation of the turbine, the turbine disk 2 bears the centrifugal force and the vibrating force through a teeth engagement of the inverted Christmas tree-shaped groove 7 and the same-shaped portion 8.

Further, once the turbine blade 1 is so assembled into the turbine disk 2, then it is so designed that the shapes of the blade groove 7 of the turbine disk 2 and the mating portion 8 at the root portion of the turbine blade 1 secure a cooling medium path 9 for allowing a cooling medium to flow in the bottom portion of the blade 1.

The cooling medium (usually a compressed air) for cooling the turbine blades 1 passes through radial directional holes 10, which are the same in number as the blades of the respective stage and which are formed on the side of entrance of the turbine disk 2 and is introduced into a space 14 surrounded by sealing blocks 12 and 13.

After that, the cooling medium is introduced into the cooling medium path 9 formed at the bottom portion of the inverted Christmas tree-shaped portion 8, enters a passage (not shown) formed at the root portion of the turbine blade 1 and flows into the interior of the blade 1 thereby cooling the whole of the blade. The cooling medium having thus cooled the blade 1 is discharged into a subsequent gas path.

In the mentioned course of a series of flows of the cooling medium, the cooling medium path 9, which is formed between the blade groove 7 and the portion 8 formed at the root portion of the turbine blade 1, defines the space 14 surrounded by the sealing blocks 12 and 13 at the entrance of the disk 2 located on the upstream side of the above-mentioned gas path while it is defined by a sealing piece 15 and a fixing piece 16 at the exit of the disk 2 located on the downstream side of the gas path.

Normally, the upstream side sealing block 12 and the downstream side sealing piece 15 are provided for every two blades 1 and the upstream side sealing block 13 and the downstream side fixing piece 16 are provided for each blade 1 and all of these parts are assembled at their proper positions, respectively.

Accordingly, in order to assemble these parts and the other parts associated therewith, it becomes necessary to provide suitable spaces for receiving them in position so that it is unavoidable to allow gaps to be left unoccupied in some places even after they have been assembled.

In Figs. 11 and 13, reference numeral 17 designates a sealing plate for covering a small gap formed between the inverted Christmas tree-shaped groove 7 and the mating portion 8 of the same shape and since this plate 17 is usually used for each of the blades 1, there is left a space required for assembling it.

As described above, it has been usual with the conventional cooling medium path structure that there exist, in the structure, various kinds of spaces or gaps left intentionally or resultantly for the convenience of designing, manufacturing and assembling the entire structure so that even when cooling air or the like as a cooling medium is supplied through the holes drilled in the disk 2, it leaks from the gap around the cooling medium path or the sealing plate so that the cooling air or the like cannot be collected but is discharged into the gas path. Consequently, there has been a problem to take out and use of the cooling medium heated to a high temperature after used for cooling and the resultant thermal efficiency loss has been unavoidable.

SUMMARY OF THE INVENTION

The present invention has been made to eliminate the above-described disadvantages of the conventional cooling medium path structure and to provide a cooling medium path structure which is simple and which is capable of preventing the leakage of a cooling medium and facilitating the supply and collection of the cooling medium.

The cooling medium path structure for a gas turbine blade according to the present invention comprises a disk-side cooling medium path provided in a turbine disk, a blade-side cooling medium path provided in a root portion of the blade, an elbow-shaped projection forming an entrance and an exit of both ends of the blade-side cooling medium path, and a delivery block disposed between the disk-side cooling medium path and the elbow-shaped projection so as to establish communication between them, wherein the delivery block is provided with an elastic engaging section capa-

XOCID: <EP__0860587A2_I_>

ble of coming into elastic contact with at least one of the elbow-shaped projection and the disk-side cooling medium path, and the cooling medium paths of the present invention are intended to realize that the delivery of a cooling medium between the disk-side cooling medium paths and the blade-side cooling medium path is performed through the elbow-shaped projection and the delivery block such that the elastic engaging section of the delivery block comes into elastic contact with the elbow-shaped projection and the disk-side cooling medium path whereby the leakage of the cooling medium is prevented to secure the sealing performance of the cooling medium path and the flexible connection of the delivery block with the cooling medium paths is attained without giving rise to an adverse effect on the vibrating characteristic of the gas turbine blade.

With the basic structure described above, another feature of the present invention resides in that the elastic engaging section of the delivery block is formed of a ring-shaped projection and a plurality of slits extending axially from the open ends of the delivery block such that the ring-shaped projection comes into line-contact with the mating cooling medium path so that the flexibility of the delivery block with respect to the axial deviation from each of the cooling medium paths or the movement of the vibrations etc. of the blades is secured to a sufficient degree and the presence of the slits at the open ends of the delivery block secures the spring forces of the delivery block at both of the open ends resulting in further securing the sealing performance by the line contact of each of the projections with the mating cooling medium path.

Still another feature of the present invention resides in that the elastic engaging section of the delivery block is formed such that a plurality of ring-shaped members circumscribing the inner surface of the elbow-shaped projection or the disk-side cooling medium path and a plurality of ring-shaped members inscribing the outer surface of the delivery block are laid one above another, respectively, and the ring-shaped members which come into contact with the inner surface of each of the cooling medium paths and the ring-shaped members which come into contact with the outer surface of the delivery block share their sealing positions, respectively. Further, since the respective ring-shaped members are urged toward the blade side due to a centrifugal force, their close contactability and sealing property are secured and also since the ring-shaped members themselves are movable in the radial direction, their flexibility with respect to the axial deviation of the delivery block from the disk-side or blade-side cooling medium path or the movement of the vibration etc. of each of the blades can be secured.

A further feature of the present invention resides in that the intermediate portion of the delivery block exposed outside the elbow-shaped projection and the disk of the turbine is covered with a spacer band so that the relative position of the elbow-shaped projection with respect to the disk of the turbine can be securely maintained.

A further feature of the present invention resides in that the delivery block comes into screw-engagement with at least one of the elbow-shaped projection and the disk-side cooling medium path so that when the delivery block is set at a predetermined position, the surface pressure of the contact surfaces of the two members is increased by making use of the clamping force of the screw-engagement thereby improving the sealing property of the delivery block.

A further feature of the present invention resides in that where the disk-side cooling medium path and the blade-side cooling medium path are connected to each other through the elbow-shaped delivery block, E-type seal or a C-type seal is inserted into each of the connection portions of the delivery block and the two cooling medium paths so that the sealing property of the connected portions is improved by making the best use of the elastic force of the seals.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic diagram showing a structural relationship between a blade and a disk of a gas turbine according to a first embodiment of the present invention;

Fig. 2 is an illustrative view , on an enlarged scale, of an A-section as an essential portion of Fig. 1;

Fig. 3 is an illustrative view showing a partial modification of the structure shown in Fig. 2;

Fig. 4 is a schematic diagram mainly showing a delivery block disposed between a blade and a disk of a gas turbine according to a second embodiment of the present invention;

Fig. 5 is an illustrative view showing, on an enlarged scale, a state in which ring-shaped members shown in Fig. 4 are assembled;

Fig. 6 is an illustrative view showing, on an enlarged scale, a state in which the ring-shaped members shown in Fig. 4 are in operation;

Fig. 7 is a schematic diagram of a delivery block between a blade and a disk of a gas turbine according to a third embodiment of the present invention;

Fig. 8 is a schematic diagram showing a partial modification of the delivery block shown in Fig. 7;

Fig. 9 is a schematic diagram showing another partial modification of the delivery block shown in Fig. 7;

Fig. 10 is a schematic diagram showing a structural relationship between a blade and a disk of a gas turbine according to a fourth embodiment of the present invention;

Fig. 11 is a schematic diagram showing a structural relationship between a blade and a disk of a conventional gas turbine;

Fig. 12 is a schematic diagram of an upstream side of the structure shown in Fig. 11 especially when

ISDOCID: <EP___0860587A2_I_>

viewed along the arrow-indicated XII - XII line; and

Fig. 13 is a schematic diagram of a downstream side of the structure shown in Fig. 11 especially when viewed along the arrow-indicated XIII - XIII line.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A first embodiment of the present invent ion will now be described with reference to Fig. 1 wherein like parts are designated by like reference numerals used with respect to the structure of the conventional gas turbine described in the foregoing with reference to Figs. 11 through 13 and no redundant description of these like parts is made herein.

In Fig. 1, reference numeral 1 designates a turbine blade whose root portion is in the shape of an inverted Christmas tree (not shown) and which is in engagement with a groove having the same shape of an inverted Christmas tree as the blade 1 and formed in a turbine disk 2. The turbine disk 2 is provided with a plurality of radial directional cooling medium paths 10 for guiding a cooling medium. Further, in the root portion of the turbine blade 1 there is provided a cooling medium path 5 for guiding the cooling medium to a blade cooling section (not shown).

As shown in detail in Fig. 2 which is an enlarged sectional view of the A-portion shown in Fig. 1, an entrance and an exit of the cooling medium path 5 for the turbine blade 1 are formed with an elbow-shaped projection 3 where a delivery block 4 in the shape of a thin tube is disposed so as to establish communication between the disk-side cooling medium path 10 and the blade-side cooling medium path 5.

The delivery block 4 has a ring-shaped projection 4a at a position near one end thereof which is fitted in the blade-side cooling medium path 5 and a ring-shaped projection 4b at a position near the other end thereof which is fitted in the disk-side cooling medium path 10, so that the surfaces of the ring-shaped projections 4a and 4b come into line-contact with the inner peripheral surfaces of the cooling medium paths 5 and 10, respectively.

Further, the delivery block 4 is provided at both ends thereof with a plurality of slits 4c extending in the axial direction of the delivery block 4 from near the ring-shaped projections 4a and 4b up to the ends, respectively. Further, the intermediate portion of the delivery block 4, that is, the portion lying outside the cooling medium paths 5 and 10 is wound with a spacer band 6 around its outer peripheral surface.

With the above structure, since the ring-shaped projections 4a and 4b on both sides of the delivery block 4 are in line-contact with the inner peripheral surfaces of the cooling medium paths 5 and 10, the flexibility of the delivery block 4 against a possible deviation of the axis thereof from the axis of each of the cooling medium paths 5 and 10 or against a possible movement of vibrations etc. is maintained to thereby secure the sealing property of the delivery block 4 at the line-contact portions.

In addition, due to the provision of the plurality of slits 4c extending from near the projections 4a and 4b up to each end of the delivery block 4, a spring force acts on each of the projections 4a and 4b so that the line-contacts of the projections 4a and 4b with the cooling medium paths 5 and 10 can be further secured.

Further, the delivery block 4 shown by solid lines in Fig. 2 is set up at a position in such a manner that, as shown by a two-dot chain line L, the lower end of the delivery block 4 is inserted into the disk-side cooling medium path 10 and then the upper end thereof is inserted into the blade-side cooling medium path 5 in the elbow-shaped projection 3 while the lower end thereof is raised.

After the above process, the outer peripheral surface of the intermediate portion of the delivery block 4 lying outside the cooling medium paths 5 and 10 is covered with the spacer band 6 so that the delivery block 4 is held in position and protected against any external damage.

It is to be noted that the description here is made in mind with a case where a cooling medium is supplied from the disc-side cooling medium path 10 toward the blade-side cooling medium path 5, however, there is also a flow of a cooling medium collection system which is substantially right and left symmetrical and extends from the blade side to the disk side and since this collecting system is substantially the same in structure, function and effect as the supply system, the present invention will be described in this specification by laying stress on the cooling medium supply system as covering also the collecting system.

Further, a partial modification of said embodiment of the present invent ion is shown in Fig. 3 in which the elbow-shaped projection 3a is formed not integrally with, but separately from, the blade root portion and a terminal end of the projection 3a is inserted into the blade-side cooling medium path 5 to be integrated therewith by a seal weld 3b.

Thus, by so forming the elbow-shaped projection 3a, it is

It should be noted that the remaining structure and function of the delivery block 4 and others are the same as those shown in Fig. 2 and illustration thereof is omitted.

Next, a second embodiment of the present invention will be described with reference to Figs. 4 through 6 wherein like parts are designated by like reference numerals with no redundant description of the like parts.

In this second embodiment, a plurality of ring-shaped members 7a - 7e are arranged in layers at a position where the delivery block 4 is fitted into the blade-side cooling medium path 5 and a plurality of ring-shaped members 7f - 7j are arranged in layers at a posi-

XOCID: <EP__0860587A2_I_>

tion where the delivery block 4 is fitted into the disk-side cooling medium path 10. These ring-shaped members 7a - 7j have different inner and outer diameters between adjacent ring-shaped members alternately in the vertical direction and are made of materials having different coefficient of thermal expansion with the members of larger diameters having a larger coefficient of thermal expansion and vice versa.

That is, each of the members 7a, 7c, 7e and each of the members 7f, 7h, 7j are of a larger diameter and the outer peripheral surface thereof substantially circumscribes the inner surface of each of the cooling medium paths 5 and 10 while the inner peripheral surface thereof keeps a sufficient gap from the outer peripheral surface of the delivery block 4. Further, each of the members 7b, 7d which are arranged alternately with the members 7a, 7c, 7e and each of the members 7g, 7i which are arranged alternately with the members 7f, 7h and 7j are of a small diameter and the outer peripheral surface thereof keeps a sufficient gap from the inner peripheral surface of each of the cooling medium paths 5 and 10 while the inner peripheral surface thereof substantially inscribe the outer peripheral surface of the delivery block 4.

Further, the upper ring-shaped members 7a - 7e fitted in the blade-side cooling medium path 5 are arranged in layers substantially in close contact with one another and likewise, the lower ring-shaped members 7f - 7j are arranged in layers substantially in close contact with one another.

The above conditions of the ring-shaped members are shown in Figs. 5 and 6 on an enlarged scale. That is, as shown in Fig. 5, the ring-shaped members 7a - 7j are arranged such that in order to secure a freedom of assembly, they keep a slight gap "a" (substantially equal to a contact) from the respective cooling medium paths 5 and 10 and a like slight gap "b" from the delivery block 4 and also keep a like gap "c" between themselves adjacent to one another in the vertical direction but when the gas turbine is in operation, the above-mentioned gaps a - c change to a' - c' due to a change in thermal expansion as shown in Fig. 6 so that the ring-shaped members are securely brought into close contact with one another so as to be in a completely gap-less state.

From the above circumstance, in this specification, the gaps a - c shown in Fig. 5 with respect to the ring-shaped members are described as being substantially equal to a contact. In this embodiment of the present invention, due to the arrangement of the ring-shaped members 7a - 7j in the above manner, the sealing property of the structure in both the radial and vertical directions is secured by the close contact of the ring-shaped members with the cooling medium paths 5 and 10, the delivery block 4 or among themselves and further, due to the sufficient gaps provided on the side opposite the contact portions of the ring-shaped members 7a - 7j, the flexibility of the structure against the axial displacement between the blade-side and disk-side cooling medium paths 5 and 10 or against the movement of vibrations etc. of the blades can be secured.

Next, a third embodiment of the present invention will be described with reference to Figs. 7 through 9 wherein like parts are designated by like reference numerals used with respect to the above-described conventional structure and the structures according to the first and second embodiment of the present invention and a redundant description of these like parts is omitted.

This embodiment of the present invention features that the connection of the delivery block 4 to the turbine disk 2 or the elbow-shaped projection 3 is performed through a screw-mechanism . That is, the structure shown in Fig. 7 is such that a screw-threaded ring 8 having its inner and outer surfaces screw-threaded is screwed into the turbine disk 2, the delivery block 4 is brought into engagement with the inner screw-threaded surface of the ring 8 thereby securing the sealing property of the structure through such screw-engagement surfaces.

In assembly, the ring 8 is set to a predetermined position shown in Fig. 7, then the delivery block 4 is caused to sink below the ring 8 as shown by a two-dot chain line and after that, the delivery block 4 is raised upward as it is turned round to thereby set the delivery block 4 to the predetermined position shown in the figure.

The sealing of the delivery block 4 with respect to the blade-side cooling medium path 5 is taken charge of by a flexible ring-shaped projection 4a while the sealing of the delivery block 4 with respect to the disk-side cooling medium path 10 is taken charge of by the sealing surfaces 8a and 8b of the screw-threaded ring 8 coming into engagement with the the disc 2 and the delivery block 4.

Figs. 8 and 9 show partial modifications of the third embodiment of the present invention of which the structure shown in Fig. 8 is such that the upper end of the delivery block 4 is expanded and the inner peripheral surface of the expanded portion is screw-threaded to have a female-screw to thereby form an engagement section 4d which is clamped with a male-screw formed on the terminal end of the elbow-shaped projection 3 with a circular ring 20 interposed therebetween.

Further, the structure shown in Fig. 9 is such that instead of expanding the upper end of the delivery block 4, the outer peripheral surface of the upper end of the delivery block 4 is screw-threaded to have a male-screwed engagement section 4e which is clamped with the female-screwed terminal end of the elbow-shaped projection 3 with the circular ring 20 interposed therebetween.

That is, according to the structures shown in Figs. 8 and 9, the delivery block 4 and the blade-side cooling medium path 5 are brought into engagement with each other by the screwed engagement sections 4d and 4e through the circular ring 20 with an improved sealing

ISDOCID: <EP__0860587A2_I_>

property while the delivery block 4 and the disk-side cooling medium path 10 are connected to each other through the ring-shaped projection 4b formed on the outer peripheral surface of the delivery block 4 thereby maintaining a sufficient degree of sealing property and flexibility.

Lastly, a fourth embodiment of the present invention will be described with reference to Fig. 10 wherein like parts are designated by like reference numerals used with respect to the above-described conventional structure and the structures according to the first through third embodiment of the present invention without making any redundant description of these like parts.

The structure according to this embodiment is such that the blade-side cooling medium path 5 and the disk-side cooling medium path 10 are made to communicate with an elbow-shaped delivery block 9.

That is, the elbow-shaped delivery block 9 is connected to the disk-side cooling medium path 10 by clamping them with a bolt 24. In that case, a C-type seal 22 is interposed between them to thereby improve the sealing property of the flange surface.

At the same time, the elbow-shaped delivery block 9 has an E-type seal 21 interposed in the shown arrangement at the upper end thereof and is connected to the root portion of the mating blade by means of bolts and the like (not shown) to thereby establish its communication with the blade-side cooling medium path 5.

Further, at the connection portion in which the E-type seal 21 is interposed, there is arranged a cover plate 23 so as to cover the connection connection portion.

In the case of this fourth embodiment, the blade-side cooling medium path 5 and the disk-side cooling medium path 10 are made to communicate with each other by the elbow-shaped delivery block 9 in the above-described manner and in that case, since the C-type seal 22 and the E-type seal 21 are interposed therein, the sealing property of one of the connection portions is secured by the C-type seal 22 while the sealing property of the other connection portion is secured by the E-type seal 21.

Furthermore, since the E-type seal 21 is arranged with its inner side directed inward as shown, a spring force generates in the E-type seal 21 due to the difference between the pressure of the cooling medium flowing inside and the pressure outside the E-type seal 21 so that the sealing property of the E-type seal 21 is further secured and at the same time, since the E-type seal 21 is brought into line-contacts with the blade root portion and the elbow-shaped delivery block 9, the flexibility of these contact portions can be secured,

It should be noted that although the present invention has been described with reference to several embodiments shown in the drawings, the invention is not limited there to and it goes without saying that various kinds of modifications and changes may be made on the concrete structure of the invention without departing from the scope of the present invention.

As described above, the present invention provides a cooling medium path structure for the blades of a gas turbine, which comprises a disk-side cooling medium path, a blade-side cooling medium path, an elbow-shaped projection forming an entrance and an exit at both ends of the blade-side cooling medium path and a delivery block provided with an elastic engaging section and disposed between the disk-side cooling medium path and the elbow-shaped projection so as to establish communication between them with the elastic engaging section of the delivery block coming into elastic engagement with at least one of the elbow-shaped projection and the disk-side cooling medium path whereby the delivery of the cooling medium between the disk-side and the blade-side cooling medium paths is performed securely and accurately with a sufficient degree of flexibility against vibrations etc. while keeping the sealing property of the structure because of the elastic engagement structure of the delivery block.

Accordingly, it has become possible with the present invention to securely collect the cooling medium heated to a high temperature as a result of cooling the high-temperature portion of the gas turbine and to make the best use of such high-temperature cooling medium for other purposes by taking it out .

Further, according to the present invention, since the elastic engaging section of the delivery block is formed in an extremely simple structure of the ring-shaped projections and a plurality of slits extending axially to both open ends of the delivery block, the sealing function and flexibility of the structure against the leakage of the cooling medium and vibrations etc. are displayed securely and it is possible to further improve the effect of collecting the heat of the gas turbine by the provision of such a cooling medium path structure that is excellent from economical and functional points of view.

Further, according to the present invention, the elastic engaging section of the delivery block is formed by laying one above another a plurality of ring-shaped members circumscribing the inner surface of the elbow-shaped projection or the disk-side cooling medium path and a plurality of ring-shaped members inscribing the outer surface of the delivery block so that by making use of the phenomenon of thermal expansion of the ring-shaped members contacting the inner surface of the cooling medium paths and those contacting the outer surface of the delivery block and the centrifugal force acting on the overlapped ring-shaped members, it is possible to improve the sealing effect and the flexibility of the structure thereby enabling the effective delivery of the cooling medium and to make the effective use of the heat of the high temperature of the gas turbine.

Still further, since the intermediate portion of the delivery block lying between the lbow-shaped projection and the turbine disk is covered with the spacer band, it is possible to accurately maintain the positional arrangement of the blade-side cooling medium path, the

DOCID: <EP___0860587A2_I_>

disk-side cooling medium path and the delivery block relative to one another and to perform the delivery of the cooling medium securely, thereby increasing the availability and reliability of the structure.

According to the present invention, the delivery block is brought into screw-engagement with at least one of the elbow-shaped projection and the disk-side cooling medium path so that the surface pressure of the contact surface is increased by such a screw-engagement to enable the construction of a cooling medium delivery system having a sharply improved sealing property and it is possible to sharply enhance the possibility of realization of heat collection of the turbine through the cooling medium and the effective use of the collected heat.

Moreover, the cooling medium path structure according to the present invention comprises the disk-side cooling medium path, the blade-side cooling medium path and the elbow-shaped delivery block disposed between the entrance and exit at both ends of the blade-side cooling medium path and the disk-side cooling medium path so as to establish communication between them and wherein the delivery block is brought into elastic engagement with the blade-side cooling medium path and the disk-side cooling medium path through the E-type seals or C-type seals thereby forming a cooling medium path structure for the blades of a gas turbine so that it is possible to improve and secure the sealing property and the flexibility of the structure by making use of the characteristics of the C-type or E-type seals arranged at the connection portions of the delivery block with the respective cooling medium paths and to make the structure safe, accurate and suitable for practical use.

Claims

1. A cooling medium path structure for a gas turbine blade,
characterized in comprising: a disk-side cooling medium path 10 provided in a turbine disk 2; a blade-side cooling medium path 5 provided in a root portion of the blade 1; an elbow-shaped projection 3 forming an entrance and an exit at both ends of the blade-side cooling medium path 5; and a delivery block 4 disposed between the disk-side cooling medium path 10 and the elbow-shaped projection 3 so as to establish communication therebetween, and characterized in that said delivery block 4 is provided with an elastic engaging section coming into elastic engagement with at least one of said elbow-shaped projection 3 and said disk-side cooling medium path 10.

2. The cooling medium path structure as described in Claim 1,
characterized in that the elastic engaging section of said delivery block 4 is formed of a ring-shaped projection 4a, 4b and a plurality of slits 4c extending axially from an open end of said delivery block 4.

3. The cooling medium path structure as described in Claim 1,
characterized in that the elastic engaging section of said delivery block 4 is formed in such a manner that a plurality of ring-shaped members 7a, 7c, 7e, 7f, 7h, 7j circumscribing an inner peripheral surface of said elbow-shaped projection 3 or said disk-side cooling medium path 10 and a plurality of ring-shaped members 7b, 7d, 7g, 7i inscribing an outer peripheral surface of said delivery block 4 are laid one above another, respectively.

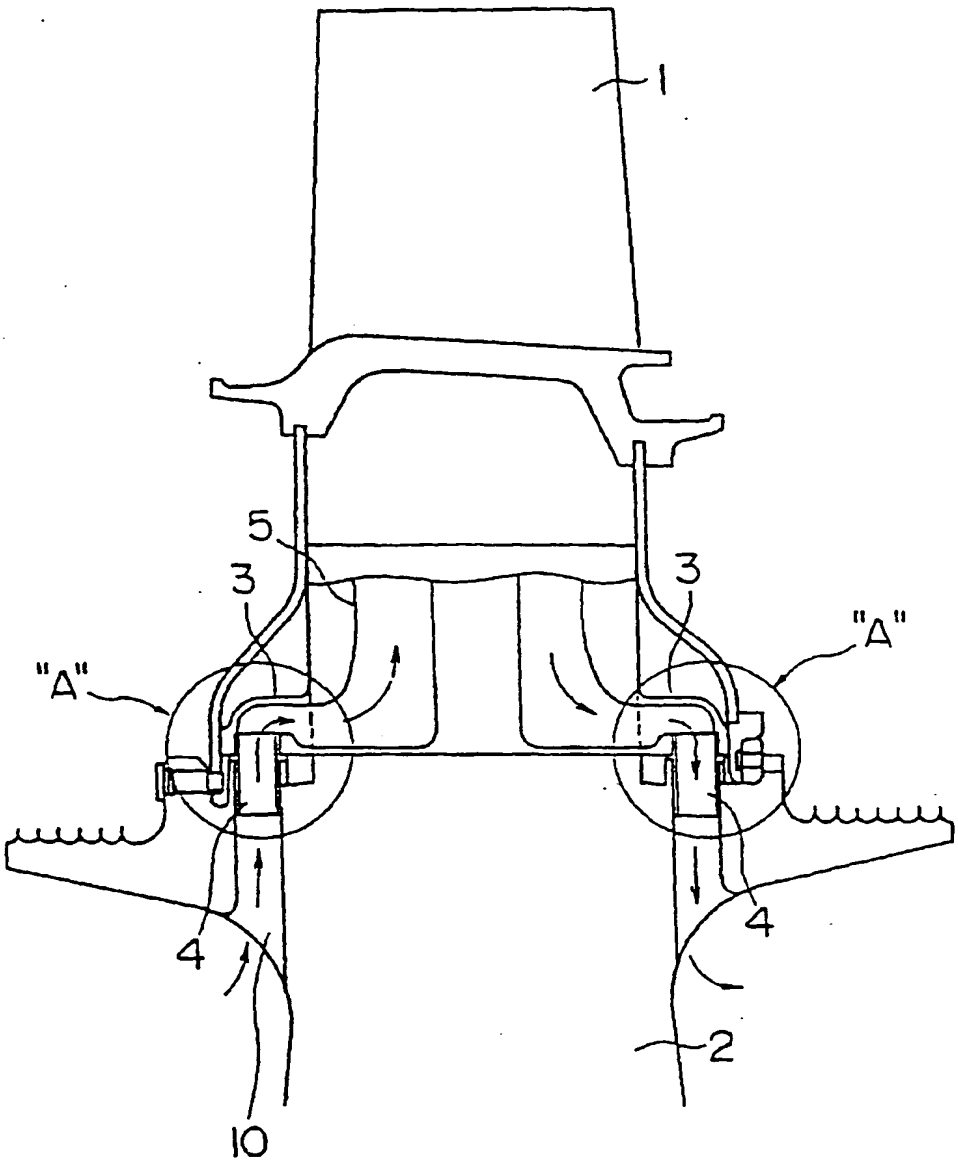
4. The cooling medium path structure as described in Claim 2 or 3,
characterized in that said delivery block 4 is covered with a spacer band 6 between said elbow-shaped projection 3 and said turbine disk 2.

5. The cooling medium path structure as described in Claim 1,
characterized in that said delivery block 4 is in screw-engagement with at least one of said elbow-shaped projection 3 and said disk-side cooling medium path 10.

6. A cooling medium path structure for a gas turbine blade,
characterized in comprising: a disk-side cooling medium path 10 formed in a turbine disk 2; a blade-side cooling medium path 5 formed in a root portion of the blade 1; and an elbow-shaped delivery block 9 disposed between an entrance and an exit at both ends of said blade-side cooling medium path 5 and said disk-side cooling medium path 10 so as to establish communication therebetween, and characterized in that a connect ion portion of said delivery block 9 with said blade-side cooling medium path 5 or said disk-side cooling medium path 10 is made elastically with an E-type seal 21 or a C-type seal 22 interposed therebetween.

\SDOCID: <EP___0860587A2_I_>

Fig. 1



)OCID: <EP___0860587A2_I_>

Fig. 2

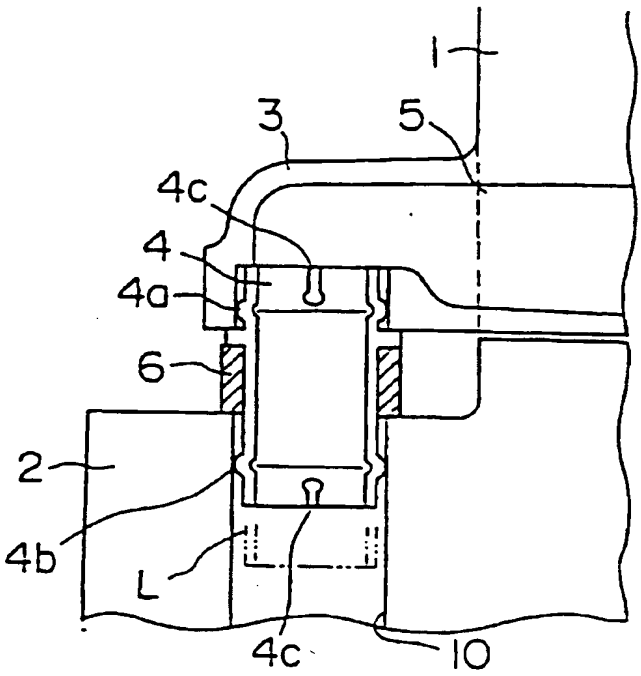
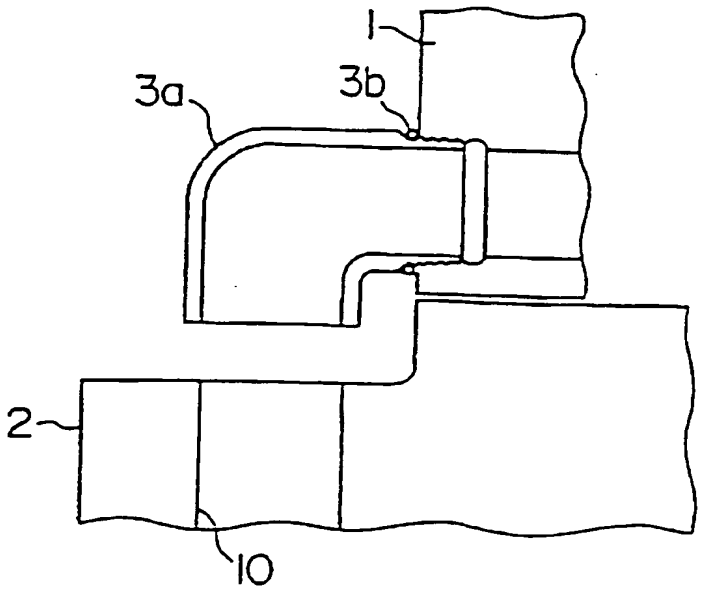
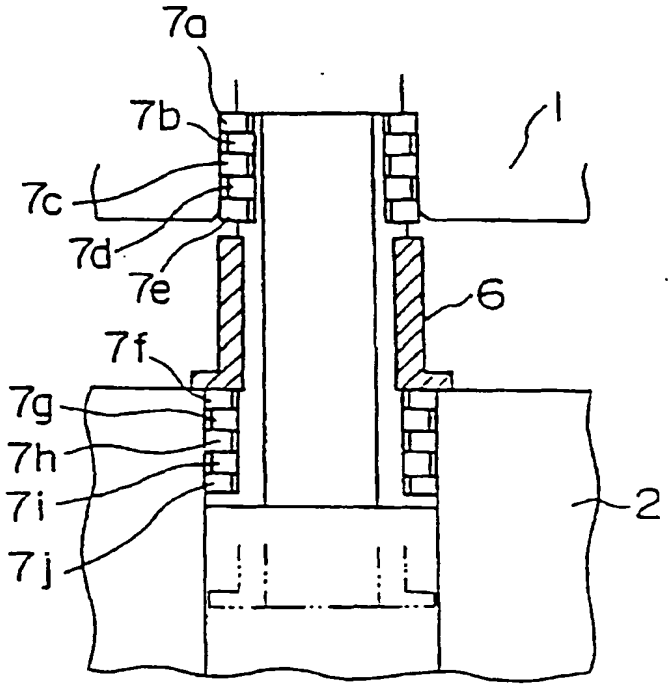


Fig. 3



ISDOCID: <EP___0860587A2_I_>

Fig. 4



DOCID: <EP___0860587A2_I_>

Fig. 5

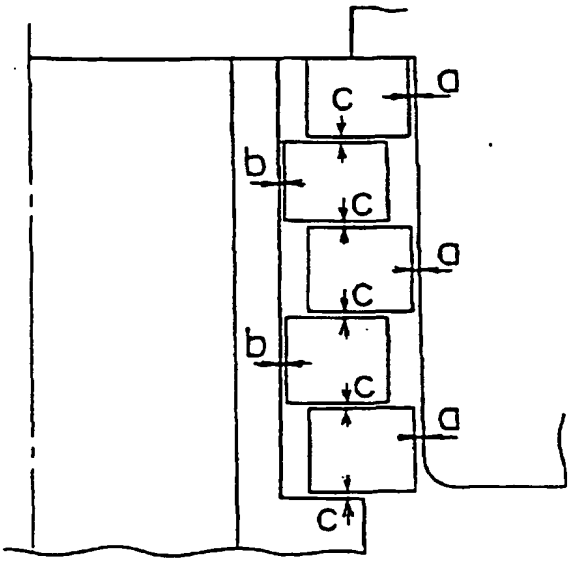
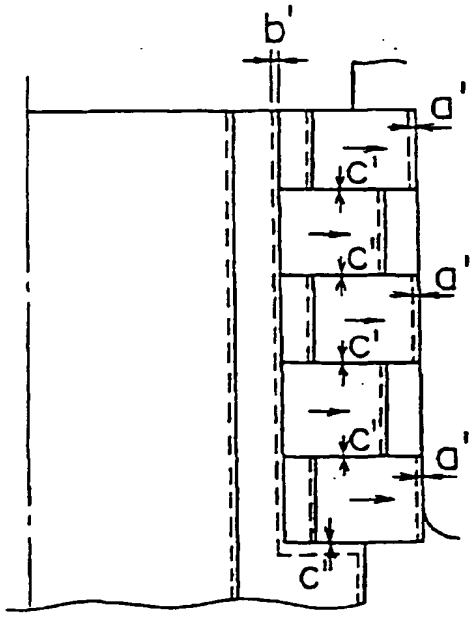
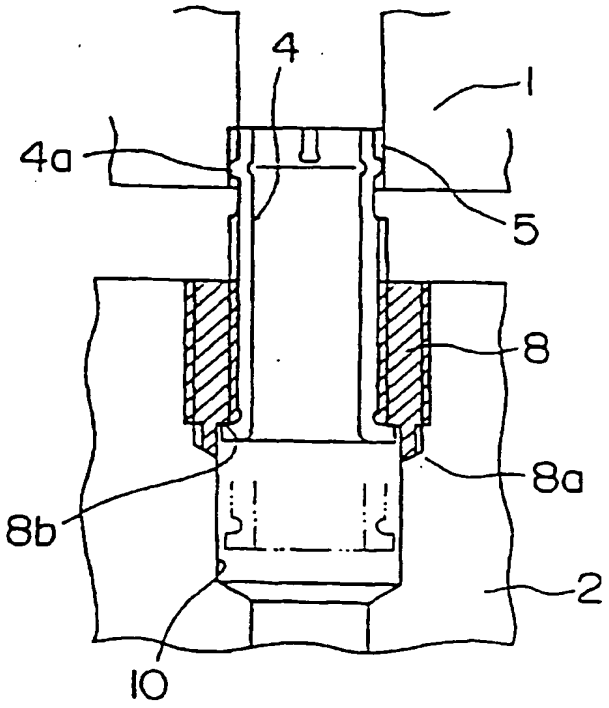


Fig. 6



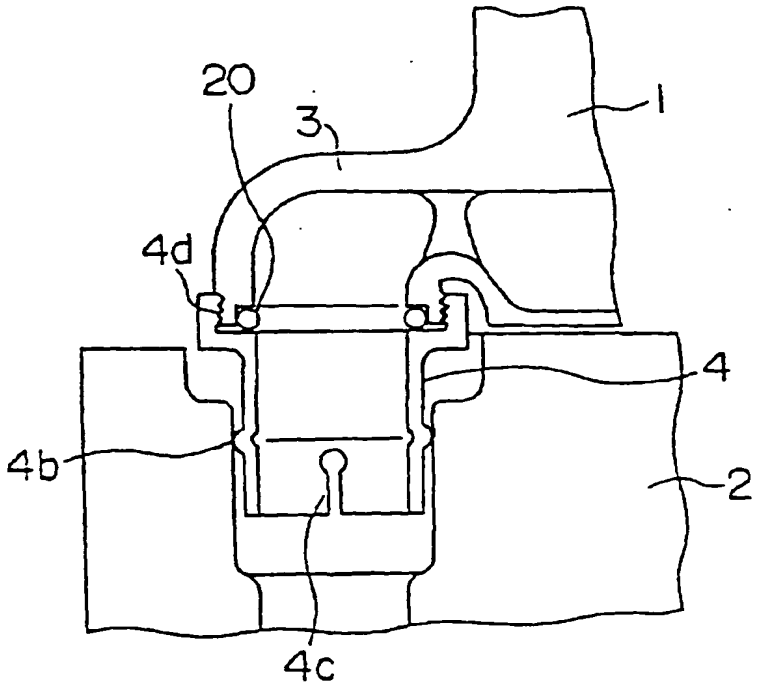
\SDOCID: <EP___0860587A2_I_>

Fig. 7



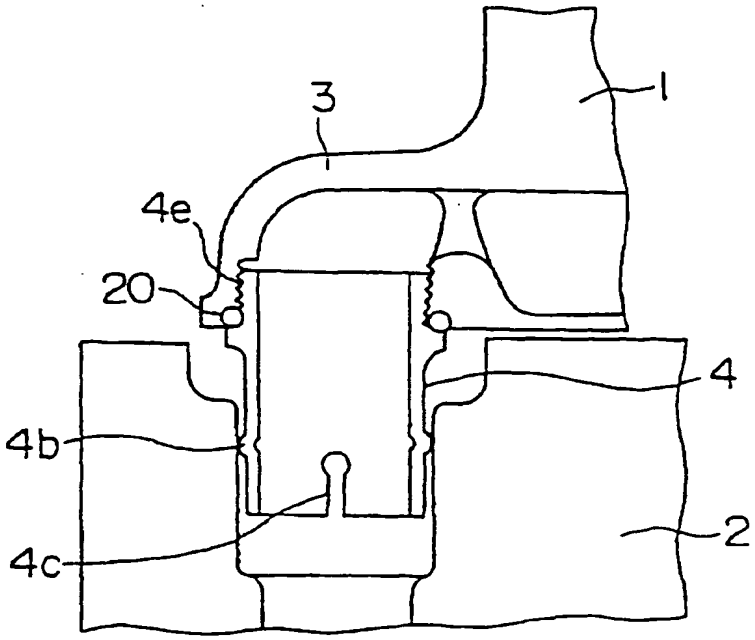
EDOCID: <EP___0860587A2_I_>

Fig. 8



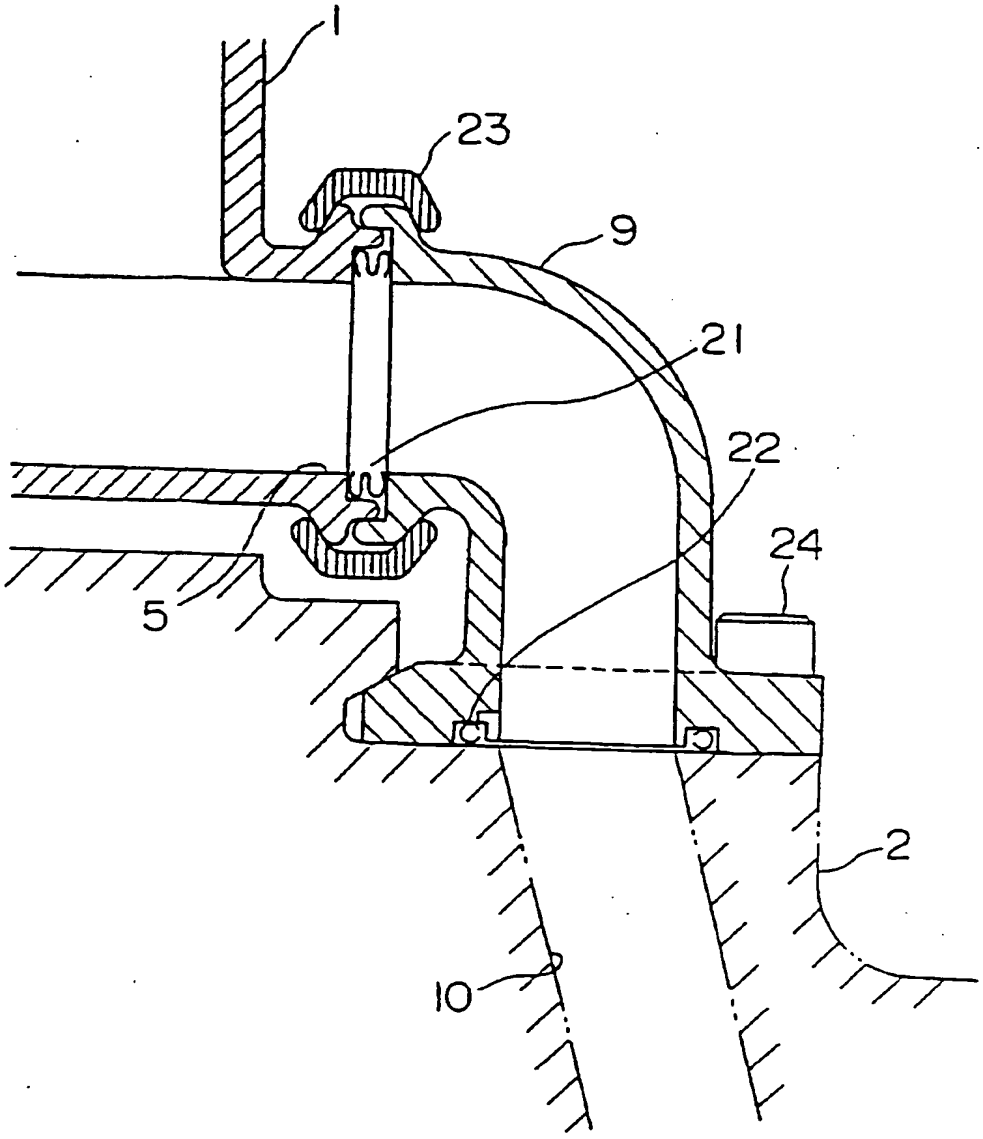
SDOCID: <EP___0860587A2_I_>

Fig. 9



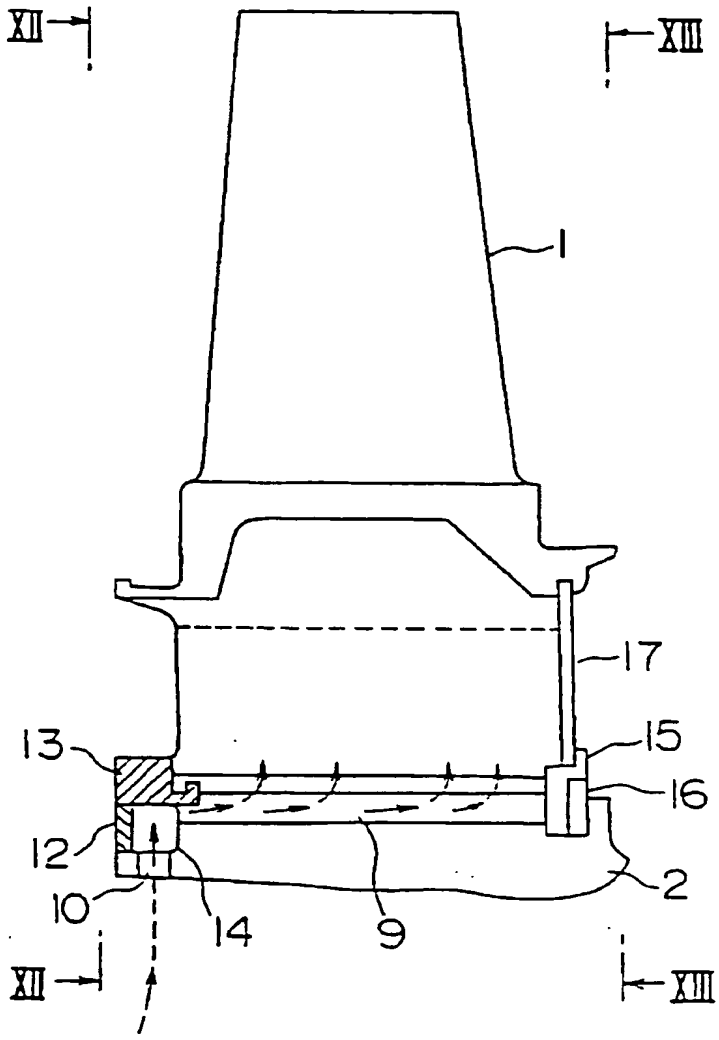
;DOCID: <EP___0860587A2_I_>

Fig. 10



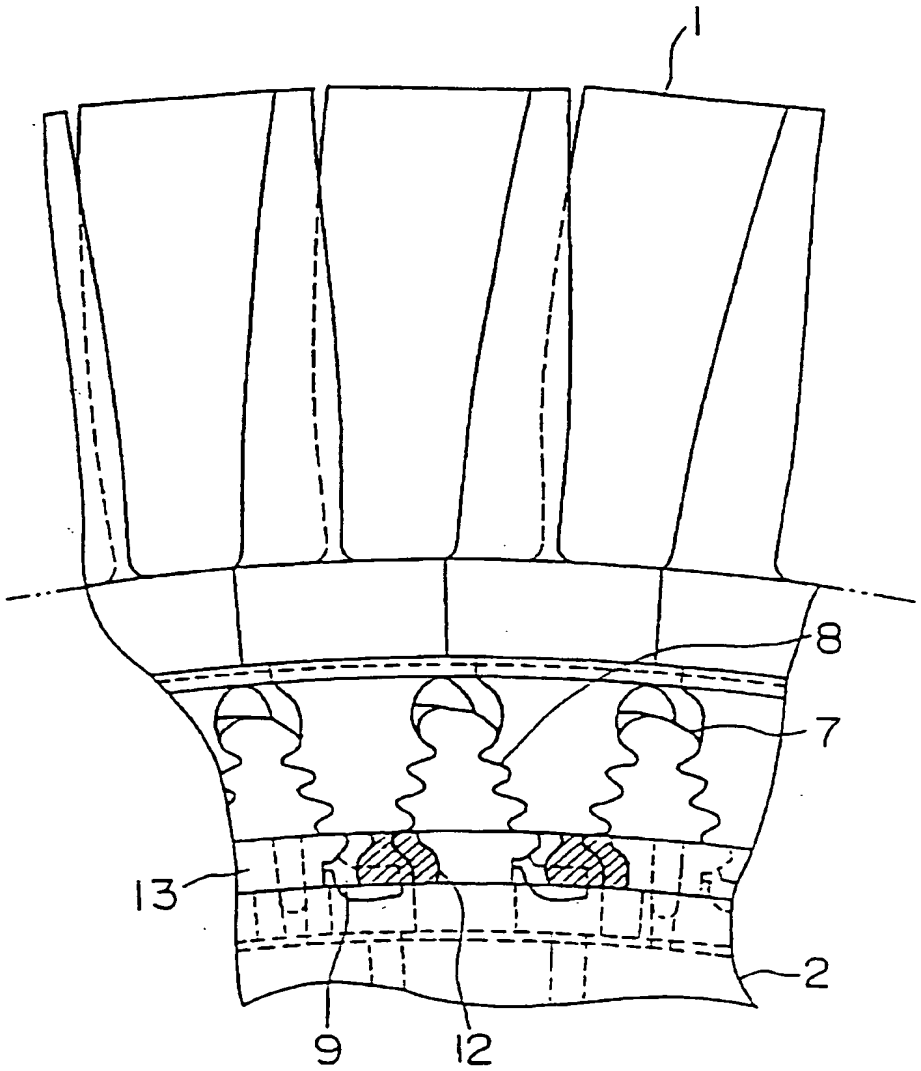
SDOCID: <EP___0860587A2_I_>

Fig. 11



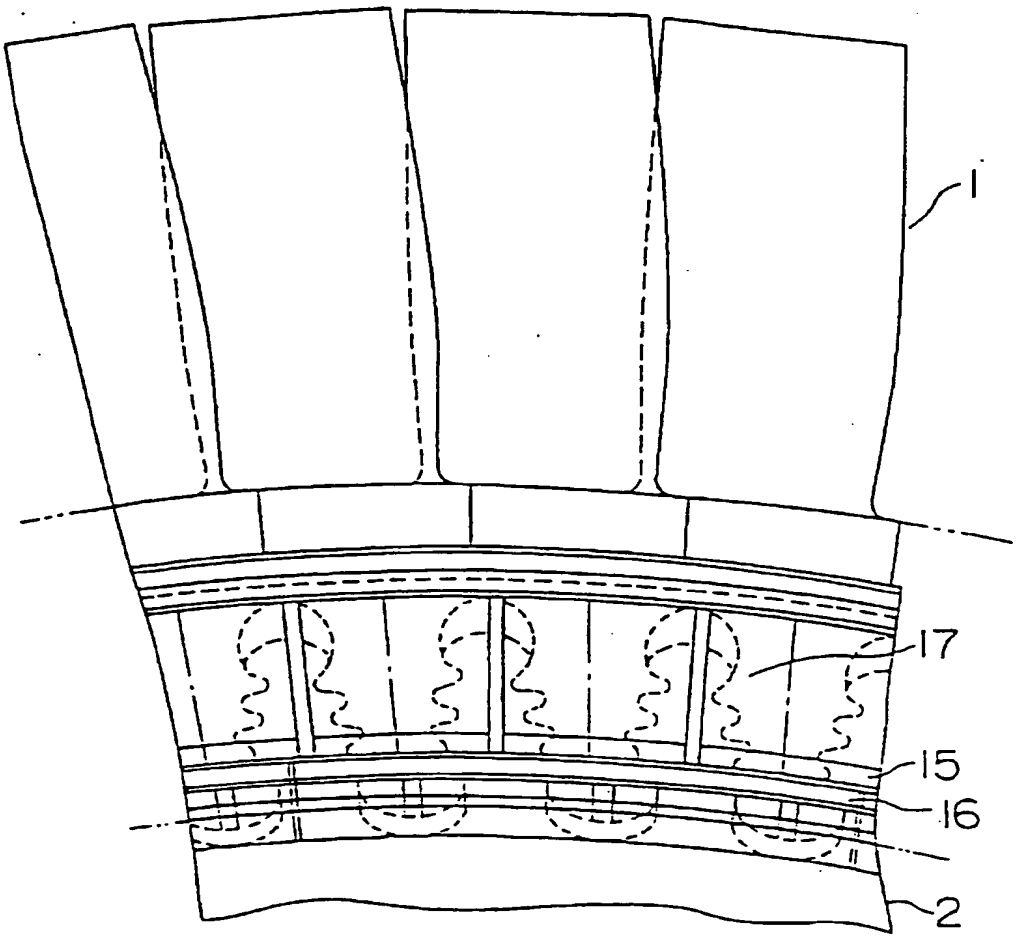
DOCID: <EP___0860587A2_I_>

Fig. 12



SDOCID: <EP___0860587A2_I_>

Fig. 13



:DOCID: <EP___0860587A2_I_>

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 860 587 A3

(12) EUROPEAN PATENT APPLICATION

(88) Date of publication A3:
21.03.2001 Bulletin 2001/12

(43) Date of publication A2:
26.08.1998 Bulletin 1998/35

(21) Application number: **98102563.8**

(22) Date of filing: **13.02.1998**

(51) Int. Cl.[7]: **F01D 5/08**

(84) Designated Contracting States:
AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **21.02.1997 JP 3764797**

(71) Applicant:
Mitsubishi Heavy Industries, Ltd.
Tokyo 100-0005 (JP)

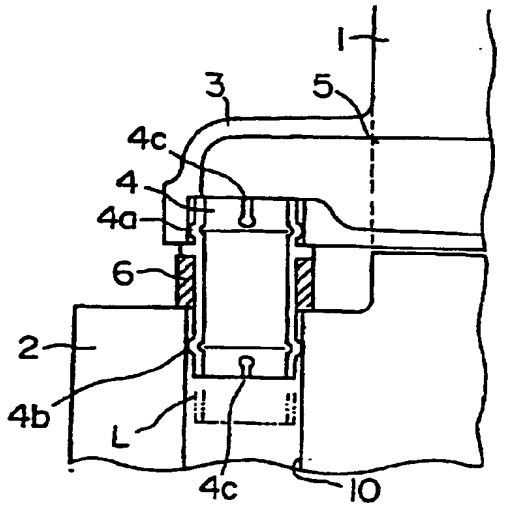
(72) Inventor:
Matsuo, Asaharu,
Mitsubishi Heavy Industries Ltd.
Takasago-shi, Hyogo-ken, 676-8686 (JP)

(74) Representative:
Henkel, Feiler, Hänzel
Möhlstrasse 37
81675 München (DE)

(54) Connector for the transfer of a cooling fluid from a rotor disc to a turbomachine blade

(57) An improved cooling medium path structure for cooling a gas turbine blade comprising a disk-side cooling medium path, a blade-side cooling medium path formed at the root portion of the blade and a delivery block disposed between the two cooling medium paths so as to establish communication between them. The delivery block is provided with an elastic engaging section which comes into elastic and line- contact with the disk-side cooling medium path and the blade-side cooling medium path whereby the sealing property of the contact portions of the structure is secured to allow a cooling medium to be supplied without leaking from the cooling medium paths and the heat of the cooling medium generated as a result of cooling the high-temperature portion of the gas turbine can be taken out so as to make the best use of it for other purposes.

Fig. 2



EP 0 860 587 A3

!SDOCID: <EP___0860587A3_I_>

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 10 2563

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	GB 2 224 082 A (ROLLS ROYCE PLC) 25 April 1990 (1990-04-25) * abstract; figure 2 *	1-6	F01D5/08
A	US 5 318 404 A (CARRENO DIETHER E ET AL) 7 June 1994 (1994-06-07) * column 5, line 24 - column 6, line 47; figures 2,4,6 *	1-6	
A	US 4 136 516 A (CORSMEIER ROBERT J) 30 January 1979 (1979-01-30) * column 6, line 12-25; figures 4,7 *	1-6	
A	US 3 804 551 A (MOORE J) 16 April 1974 (1974-04-16) * column 6, line 25-51; figure 4 *	1-6	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
F01D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	19 January 2001	Acton, P

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

EDOCID: <EP___0860587A3_I_>

European Patent Office

Application Number
EP 98 10 2563

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☒ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

!SDOCID: <EP___0860587A3_I_>

European Patent Office

LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 98 10 2563

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. Claims: 1-5

   Elastic juncture between two cooling medium paths

2. Claim : 6

   Junction with sealings between two cooling medium paths

XOCID: <EP___0860587A3_I_>

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 98 10 2563

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

19-01-2001

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2224082 A	25-04-1990	NONE	
US 5318404 A	07-06-1994	CA 2103428 A	01-07-1994
		EP 0605155 A	06-07-1994
		JP 6257403 A	13-09-1994
US 4136516 A	30-01-1979	DE 2823496 A	14-12-1978
		FR 2393152 A	29-12-1978
		GB 1600109 A	14-10-1981
		IT 1096412 B	26-08-1985
		JP 54016016 A	06-02-1979
US 3804551 A	16-04-1974	DE 2336952 A	14-03-1974
		FR 2198052 A	29-03-1974
		GB 1437618 A	03-06-1976
		IT 993116 B	30-09-1975
		JP 1102262 C	25-06-1982
		JP 49092413 A	03-09-1974
		JP 56044241 B	19-10-1981
		NL 7311237 A	05-03-1974
		NO 143880 B	19-01-1981
		SU 670237 A	25-06-1979

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

EDOCID: <EP___0860587A3_I_>